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## MODERN SCIENTIFIC INVESTIGATION: ITS METHODS AND TENDENCIES.*

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*Gentlemen of the American Association for the Advancement of Science:* Every day of our lives we hear that this is an age of *progress;* and that it is so we find evidence at every turn. The rapidity with which effects follow causes in human events, the celerity with which the plan is carried into execution, gives to a *year* in the experience of one of the present generation the practical value of a lifetime in ages past. Much labor has been expended on the exposition of the causes of the mental activity of the present age, and of the grand achievements which have attended it; and yet, the key to the whole enigma is to be found in the universal adoption of the comparatively new system of inductive reasoning. It would be foreign to my purpose to attempt to illustrate or defend this proposition, and I must therefore trust to its acceptance without argument, while we pass to con-

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sider that branch of the subject which more immediately demands our attention.

Although the progress of the age to which I have referred has been a matter of wonder and delight to all students of humanity and civilization, many of our best men have been somewhat alarmed and dizzed by it; and while accepting the achievements of modern industry and thought as full of present good and future promise, they are not a little concerned lest our railroad speed of progress should lead to its legitimate consequences, a final crash—not of things material, but of those of infinitely more value—of opinions and of faith. As often as it is boasted that this is preëminently an age of progress, that boast is met by the inevitable "but" (which qualifies our praise of all things earthly) "it is equally an age of scepticism." For the truth of this assertion the proof is nearly as palpable as of the other; and in view of the ruthlessness with which the man of the present removes ancient landmarks and profanes shrines hallowed by the faith of centuries, it is not surprising that many of the good and wise among us should deplore a liberty of thought leading, in their view, inevitably to license; and mourn over this wide-spread scepticism as an evil and inscrutable disease that has fallen upon the minds and hearts of men.

Now for every consequence there must be an adequate cause; and while confessing the fact of this modern lack of faith, I have thought that a few moments given to an analysis of it, and an attempt to trace it to its source might not be wholly misspent,—might possibly, indeed, result in giving a grain of encouragement to those who look with distrust and dread upon the investigations and discussions which now occupy so large a portion of the time and thought of our men of science.

If the wheels of time could, for our benefit, be rolled back, and we could see in all its details the civilization of Europe three or four hundred years ago, we should find that our so much respected ancestors, who fill so large a space on the page of history, were little better than barbarians. Among the English, the French, the Germans, Spanish and Italians we should find a phase of civilization which, excepting that it included the elements —as yet but imperfectly developed—of a true religious faith, is scarcely to be preferred to that of the Chinese. Aside from the vast difference perceptible between the civilization of that epoch and ours, as exhibited in the political condition of the people, in their social economy and morals, the general intellectual darkness of the period referred to could not fail to impress us both profoundly and painfully. Out of that darkness and chaos have come, as if by magic, all our modern democracy with its individual liberty and dignity, all our civil and religious freedom, all our philanthropy and benevolence, all our diffused comfort and luxury, most of our good manners and good morals, and all the splendid achievements of our modern scientific investigation.

It is unnecessary for me here to describe in detail the origin and growth of modern science. That has been so well done by Dr. Whewell that all men of education are familiar with the steps by which the grand, beautiful, and symmetrical fabric formed by the grouping of the natural sciences has acquired its present lofty proportions.

Previous to the period when the Baconian philosophy was accepted as a guide in scientific investigation, but one department of science had attained a development which has any considerable claim to our respect. Mathematics, both pure and applied, had been assiduously cultivated

from the remotest antiquity, and with a degree of success which has left to modern investigators little more than the elaboration of the thoughts of their predecessors. In Metaphysics—which had claimed even a larger share of the attention of the scholars of antiquity—little progress had been made. Perhaps I am justified in saying little progress was possible, inasmuch as in the light of all the great material discoveries of modern times the metaphysicians of the present day are debating, with as little harmony of opinion, the same questions that divided the rival schools of the Greeks. Each successive generation has had its two parties of idealists and realists, who have discussed the intangible problems which absorbed the great minds of Plato and Aristotle with a degree of enthusiasm and energy—and it may be of acrimony—which seems hardly compensated by any expansion of the human intellect or amelioration of the condition of mankind.

Of the *physical sciences* we may say that, except Astronomy, no one had an existence prior to the time of Bacon. There were men of vast learning, and much that was *called* science in the mass of reported observation that had been accumulating from century to century, until it had become "*rudis indigestaque moles*," in which—though it constituted the pride of universities, the intellectual capital with which the savant thought himself rich, and that on which the professional man depended for success—there was far more error than truth, and of which the study was sure to mislead and likely to injure. In these circumstances the task before the scientific reformer was one far more difficult than that of clearing the Augean stables; no less, in fact, than to seat himself before this great heap of rubbish, this mass of truth and error,—of the sublimest philosophy with the wildest fiction,—to pa-

tiently winnow out the grains of truth, and from infinitesimal facts build up a fabric that should have a sure foundation below, and beauty and symmetry above. What more natural, then, than that the process adopted in winnowing this chaff-heap should be that which had given success to the only true science of the period?—that the mathematical touchstone should be the test by which every grain was tried? And such precisely was the course pursued; perhaps we may even say the only one practicable. Provided with this test, the reformer was compelled to rejudge upon its merits every proposition submitted to him, and accepted only as true such as could be demonstrated. The materials which composed the science to be reformed naturally fell into several categories. First,—That which had been *demonstrated* to be true. Second,—That which was *demonstrable*. Third,—That which was *probable*. Fourth,—That which was *possible*, and Fifth,—That which was *impossible*. Of these he systematically rejected all but the first and second classes. And this, in few words, has been the method adopted, not only in the purification of old science, but in the creation of new.

It will be seen at a glance, that in this process all that was contrary to the order of nature (supernatural or spiritual) was necessarily excluded; and it was taken for granted that the mathematical or logical faculty of the human mind was capable of solving *all* the problems of the material universe. Sir William Hamilton and others have demonstrated the inadequacy of mathematical processes as a guide to human reason, and a moment's thought will show us that our boasted intellect is incapable of grasping even all the material truths which are plainly presented to it. To illustrate: as we scan the

heavens of a clear evening, we recognize the fact that we stand as it were on a point in space, where our field of vision is limitless; the heavenly bodies stretching away into the realms of obscurity, and becoming invisible only through the imperfection of our organs of vision. Bringing to our aid the most powerful telescopes, we are apparently as far as ever from reaching the limits of the universe; and when we endeavor to *conceive* of such a limit, the reasoning faculty finds itself incapable of grasping either of the two alternatives offered to it, one or the other of which must be true. The universe must be either limited or limitless. But no man can conceive of a universe without a limit; and if it be regarded as terminated by definite boundaries, the imagination strives in vain to fill the void which reaches beyond. In fact we stand here face to face with infinity, and recognize the fact that the infinite exists without the power to comprehend it.

The same is true of time. We cannot conceive of its beginning or its end. All things which come within the scope of our senses are limited in duration and circumscribed in space, and though we prate flippantly of the infinite, the pretence that we can grasp it is simply idle talk.

Conducted on such a plan, it was inevitable that scientific investigations should be narrow and materialistic in their tendency. No matter how strong the probability in favor of the truth of a certain proposition,—though the whole fabric of society were based upon its acceptance, and it formed the foundation of civil and moral laws, controlling the actions of the philosopher himself,—if not proved consistent with nature's physical and material laws it must be rejected as unworthy to enter into the con-

struction of the edifice he was erecting. In his great task of undoing the work of blind, unreasoning faith, and wild, illogical speculation, all the fruit of such faith or speculation must be looked upon as matter valueless to his hand. We may even go further and say that were it true that the Supreme Intelligence *had* created the material universe, and by special providence modified or thwarted the general laws through which that universe was governed,—such Divine supervision, and such miraculous interposition must necessarily have been ignored.

Let it not be inferred, however, that each and all of the great men who have been engaged in this work of scientific reformation were necessarily driven to be impious iconoclasts, or that in their efforts to emancipate themselves from time-honored errors, they necessarily prostituted the liberty they gained to selfish or sensual purposes. On the contrary, the most important advances which the human intellect has made within these later centuries have been due to the efforts of men of the purest and most conscientious character; men whose lives were devoted with the utmost singleness of purpose to determine *what is truth;* men who, knowing that all truth must be consistent with all other truth, were willing to go whithersoever it should lead. If it shall prove that they have been occupied with "mint, anise, and cumin," omitting the "weightier matters of the law," it is also true that in no other way could the material laws of the universe be thoroughly investigated than by making them the subjects of an absorbed and undivided attention. And it is not true, in any sense, that these devotees of science have lived in vain; for to them we mainly owe the fact, that man is not only wiser now than formerly, but that he is better and happier. It would be as just to impugn

the motives and decry the merits of the maker of our almanacs because his mathematical calculations were not interlarded with moral maxims, as to reproach the student of natural phenomena because he did his work so well, and left to others the coördination of the results of his efforts with the accepted dogmas of religious faith.

In justice to the man of science we must go still farther than this, and claim for him the position of co-laborer with, and indispensable ally to the philanthropists and moralists: for from no source have they drawn richer lessons, stronger arguments, or more eloquent illustrations than from his discoveries.

And yet while conceding conscientiousness and purity of motive to the vast majority of our men of science, and acknowledging the contributions they have made, and are making to human happiness; compelled by my sense of justice to defend their spirit, approve their methods, admire their devotion, and assert their usefulness, I cannot deny that the tendency of modern investigation is decidedly materialistic. All natural phenomena being ascribed to material and tangible causes, the search for and analysis of these causes have begotten a restless activity and an indomitable energy which will leave no stone unturned for the attainment of their object. But while this is apparent, and, indeed, inevitable, as has been seen from the sketch of the growth of modern science, I am far from sharing the alarm which it excites in the minds of many good men. Nor would I encourage or excuse that spirit of conservatism—to call it by no harsher term—which for the safety of a popular creed, would by any and all means repress, and, if possible, arrest investigations that may possibly become revolutionary and dangerous.

Such opposition, in the first place, must be fruitless. All history has proved that persecution by physical coercion or obloquy is powerless to arrest the progress of ideas, or quench the enthusiasm of the devotees of a cause approved by their moral sense. The problems before our men of science *must* be solved in the manner proposed, if human wisdom will suffice for the task. In every department of science are men actuated simply by a thirst for truth, whom neither heat nor cold, privation nor opposition will hold back from their self-appointed tasks. We may, therefore, accept it as a finality, that this problem will be carried to its logical conclusion.

In the second place, if possible, the arrest of scientific investigation would be not only undesirable, but an infinite calamity to our race. As has been so often said, truth is consistent with itself. If, therefore, our faith in this or that is based on truth, we have no cause for fear that this truth will be proved untrue by other truths. And more than this: it seems to me, that, in the reach and thoroughness of this material investigation, we may hope for such demonstration of the reality of things immaterial as shall produce a deeper and more universal *faith* than has ever yet prevailed.

Through this very spirit of scepticism which pervades the modern sciences we are compelled to exhaust all material means before we can have recourse to the supernatural. When, however, that is done, and men have tried patiently and laboriously, but in vain, to refer all natural phenomena to material causes, *then*, having proved a negative, they will be compelled to accept the existence of truth not reached by their touchstone, and faith be recognized as the highest and best knowledge.

That such will be the result is the confident expecta-

tion of many of the wisest of the scientific men whose influence is looked upon with such alarm by those who, in their anxiety for their faith, demonstrate its weakness.

Already, as it seems to me, scientists have reached the wall of adamant—the *inscrutable*—that surrounds them on every side, and, erelong, we may expect to see them return to that heap of chaff from which the germs of modern science were winnowed, with the conviction that there were there left buried other germs of other and higher truths than those they gleaned; truths without which human knowledge must be a dwarfed and deformed thing.

A few illustrations from the many that might be cited will suffice to show the materialistic tendency of modern science. In "Pure Philosophy,"—as the students of Psychology are fond of styling their science,—the names alone of Compte, Buckle, Herbert Spencer, Mill, and Draper will suggest the more prominent characters of the school they may be said to represent. The most conspicuous feature in the "Positive Philosophy" of Compte is the effort it exhibits to coördinate the laws of mind with those of matter. Spencer is a thorough-going mental Darwinist, who considers the highest attributes of the human mind, the loftiest aspirations of the soul, as only developed instincts, as these were but developed sensations. Mill, more guarded, more fully inspired with the spirit of the age,—which *believes* nothing, and is a foe to speculation,—leaves the *history* of our faculties to be written, if at all, by others; takes them as they are, but reasons of conscience and free-will with an independence of popular belief that savors more of the material than the spiritual school. Buckle wore himself out in a vain chase

after an *ignis fatuus*, an inherent, inflexible law of human progress, and hence of human history. Draper is a developmentist, but not a Darwinian. With him civilization is a definite stage in the growth of mind; a degree of development to which it is impelled by a *vis a tergo*, not unlike, in kind, to that which evolves from the germ, the bud, the leaf, the flower, and the fruit in plant-life,—a development which, when unchecked and free, will be regular and inevitable, but which is so modified by the accidents of race, climate, soil, geographical position, etc., as to render it difficult to say whether the rule or the exception has, in his judgment, greatest potency. If he were a consistent Darwinist, the accidents of development would be its law.

Among the students of "Social Science,"—a new and important member of the sisterhood of sciences,—as in most of the other departments of modern investigation, two groups of devotees are found; one patiently and conscientiously studying the problems of social organization, inspired with the true spirit of the Baconian Philosophy, ready to follow whithersoever the facts shall lead, and having for their object that noblest of all objects, the increase of human happiness. The other class of investigators, in whom the bump of destructiveness is largely developed, would be delighted to tear down the whole fabric of society, and abrogate all laws, both human and divine. Looking upon man as literally the creature of circumstances, as an inert atom driven about by material forces, conscience and responsibility are by them repudiated, and laws and penalties regarded simply as relics of barbaric despotism. The dreary soul-killing creed of these fatalists is fortunately so repugnant to the reason and feelings of the majority of men, that there is little

danger that their efforts will reach their legitimate conclusion in throwing society into a state of anarchy and chaos.

In Theology or Biblical Science the tendency of modern investigation is so distinctly felt, that I need only refer to it. The spirit of independent criticism, so noticeable elsewhere, is still more conspicuous here; assuming sometimes the form of derisive scepticism, but oftener of cold, passionless judgment on the reported facts of sacred history, or the psychological phenomena of religious faith, studied simply as scientific problems.

The names of Strauss, Renan, and Colenso, will suggest the results to which men, possibly honest, are led by this so-styled "enlightened and emancipated spirit of enquiry"; while "Ecce Homo" and cognate productions may be considered as the fruit of this spirit, tempered by a very liberal but apparently sincere faith.

Aside from these more marked examples of the decided "set" in the tide of modern religious opinions, we everywhere see evidences that no part of the religious world is unmoved by it. In every sect and section an impulse is felt to substitute for abstract faith, the "faith without works," rather a characteristic of the religion of our fathers, and not unknown at present—that other faith which is evidenced *by* works. In other words; in our day more and more value is being attached to *this life*, as a sphere for religious effort and experience. With what propriety, I leave to the individual judgment of my auditors; the faith of every sect and man is coming to be respected and valued precisely in the ratio of the purity, unselfishness, and active sympathy in the life produced by it.

While, therefore, we have less now than formerly of

the self-centred and fruitless piety of the old deacon whom I chanced to know, who excused his avarice by proclaiming that "business was one thing and religion another, and he never allowed them to interfere"; in place of that we have many an Abou Ben Adhem, and all the splendid exhibitions of modern philanthropy.

Though the golden mean displayed in the life and words of Christ is far better than either extreme, I cannot but think the present religious condition of the world is better than any which has preceded it.

So far as regards the *facts* of sacred history, it is well known that modern antiquarian researches, especially those of Leyard, Rawlinson, and Hinks, among the Assyrian inscriptions; of Champollian and Lepsius, in Egypt, have confirmed in a remarkable manner the accuracy of the historical books of the Bible.

In Ethnology—the pre-historic history of the human race—the researches of the large number of investigators who are devoted to its study have made interesting and important additions to our knowledge; but it cannot be denied that the result of such investigation has been to create general distrust of our previously accepted chronology, and give an antiquity to man such as the scholars of a previous generation would have looked upon as not only unwarranted but impious. It should be said, however, that our preconceived opinions of the antiquity of the human race—like those of the age of the earth itself—were based upon no solid foundation in nature, history, or revelation; and that our system of chronology was a matter of convention, about which there has been a wide latitude of opinion among the scholars of all ages.

In regard to the *origin* of man—whether by special creation or by development—we may confidently assert,

that modern investigation has given us no new light. Among those who have accepted the theory of a special creation, and have differed only in regard to the number of species and their places of origin or centres of creation, there has been such a diversity of opinion that all confidence in their reality and value of the bases of their reasoning has been lost. Among the advocates of a multiplicity of species and diversity of origin we have from Blumenbach to Agassiz almost every number between fifteen and three as that of distinct species of the human race, scarcely any two writers advocating the same number. We may, therefore, very fairly infer that the facts upon which their conclusions are founded, are not of a very clear and unmistakable character.

The subject of the origin of the human race brings us into the domain of zoölogy, and opens the wide question of the origin of species, which, of late years, has been shaking the moral and intellectual world as by an earthquake. While the various writers upon the origin of the human race were gathering with so much industry, and reporting with so much eloquence the proofs of a diversity of origin, the Darwinian hypothesis comes in and refers, not only all the human family, but all classes of animals and plants, to an initial point in a nucleated cell.

It would be impossible for any one to discuss, in a fair and intelligent manner, the great question of the origin of species, in anything less than a bulky volume. The merest mention is, therefore, all we can give to it at the present time. Although the appearance of Darwin's book on the Origin of Species communicated a distinct shock to the prevalent creeds, both religious and scientific, the hypothesis which it suggests, though now for

the first time distinctly formularized, was by no means new; as it enters largely into the less clearly stated development theories of Oken, Lamarck, De Maillet, and the author of the "Vestiges of Creation." There was this difference, however, that in the developmental theories of the older writers the element of *evolution* had a place; the process of development had its main spring in an inherent growth, or tendency, such as produces the evolution of the successive parts in plant-life, while, according to Darwin, the beautiful symmetry and adaptation which we see in nature is simply the form assumed by plastic matter in the mold of external circumstances.

Although this Darwinian hypothesis is looked upon by many as striking at the root of all vital faith, and is the *bête noire* of all those good men who deplore and condemn the materialistic tendency of modern science, still the purity of life of the author of the "Origin of Species," his enthusiastic devotion to the study of truth, the industry and acumen which have marked his researches, the candor and caution with which his suggestions have been made, all combine to render the obloquy and scorn with which they have been received in many quarters peculiarly unjust and in bad taste. It should also be said of Mr. Darwin, that his views on the origin of species are not inconsistent with his own acceptance of the doctrine of Revelation; and that many of our best men of science look upon his theory as not incompatible with the religious faith which is the guide of their lives, and their hope for the future. To these men it seems presumption that any mere man should restrict the Deity in his manner of vitalizing and beautifying the earth. To them it is a proof of higher wisdom and greater power in the Creator that he should endow the vital principle with such

potency that, pervaded by it, all the economy of nature, in both the animal and vegetable worlds, should be so nicely self-adjusting that, like a perfect machine from the hands of a master maker, it requires no constant tinkering to preserve the constancy and regularity of its movements.

This much I have said in view of the possible acceptance of the Darwinian theory by the scientific world. I should have said, *in limine*, however, that the Darwinian hypothesis is not accepted and can never be fully accepted by the student of science who is inspired with the spirit of the age. From the nature of things it can be proved only to a certain point, and while we accept that which is proven,—and for it sincerely thank Mr. Darwin,—that which is hypothesis, or based only upon probabilities we reject, as belonging in the category of mere theories, to disprove or purify which the modern scientific reform was inaugurated. Much, too, may be said against the sufficiency of "natural selection in the struggle of life," from observations made upon the phenomena of the economy of nature. Necessarily, the action of the Darwinian principle must be limited to the individual, literally and purely selfish; and if it can be proved that a broader influence pervades the created world, that something akin to benevolence enters into the organization of the individual, something which benefits others and not himself, one single fact establishing this truth would hurl the entire Darwinian fabric to the ground, or rather restrict it to its proper bearing upon the limits of variation, and the mooted question of "what is a species." One of the most potent influences in the perpetuation of species is fecundity in the individual, whereas we see in social insects the economy of the community is best served by a total

loss of this power in the great majority of the individuals which compose it. This objection will perhaps be met by the Darwinians with the assertion that the community, in fact, constitutes an individual; but I must confess that I find it difficult to comprehend how the sterility of the workers in ants and bees was ever introduced through the medium of modified descent, the Darwinian method, or how it is kept up from generation to generation among those individuals who have no posterity to inherit their peculiarities of structure.

The Honey Ants of Mexico offer additional difficulties. Among them a portion of the community secrete honey in the abdominal cavity until they resemble small grapes, and these individuals, during the winter, are dispatched in succession to furnish food for the other members of the colony. How, by modified descent, is this honey-making faculty transmitted, when those who possess it are systematically destroyed?

A still harder nut for the Darwinians to crack is furnished in a fact stated by Dr. Stimpson, that among the crustacea, which do not live in communities, a very large proportion of the individuals of a numerically powerful species pass their lives as neuters, or undeveloped females.

Another element in nature's economy, which at first sight suggests an objection to the Darwinian theory, is that of *beauty*, which affects others far more than the possessor. This is considered by the Darwinians simply as an attraction to the opposite sex, but as a fact we find that in the larval condition of some insects—a condition in which no propagation is effected—varieties of form and combinations of color exist which appeal to our sense of beauty scarcely less forcibly than in the perfect insects.

Again, the origin of life is left completely untouched

by the Darwinian hypothesis, and so long as the vital principle resists, as it has done, all efforts of theorists and experimenters to bring it within the category of material forces, so long we must regard the world of life as including elements not amenable to the laws which control simple inert matter.

Upon this question of the origin of life so much is being done and said that you will expect a word of reference to it at my hands, yet little more can be reported as the result of all modern research than that the origin of life is as great a mystery as ever. You will all remember how, a few years since, we were startled by the announcement of the discovery of the generation of the *Acarus Crossii;* and, while our original distrust of the accuracy of the observations of Mr. Cross was strengthened by the failure of all subsequent experimenters to reproduce his results, our unbelief is further confirmed by the unanimity of all the more modern and intelligent devotees of spontaneous generation in the assertion that life can only originate in its simplest form, that of a unicellular organism. There is no Darwinist who will concede the possibility of an animal as highly organized as an *Acarus*, with body, head, limbs, digestion, and senses, all more or less complete, being the product of spontaneous generation and not the result of slow and gradual development.

Still farther; it is known that the animal kingdom rests upon the vegetable as a base. Animals being incapable of assimilating inorganic matter could not exist without plants. Plants must therefore have preceded animals, and the fruit of spontaneous generation must be a protophyte and not a protozoan.

As I have said, the materialists have so far utterly failed to coördinate the vital force with those which we

designate as material. The beautiful and important discoveries which have followed researches into the correlation and conservation of forces by pointing to a unity of all the forces in the material world have naturally prompted efforts to centralize, with electricity, magnetism, and chemical affinity, that which we know as vital force. But a moment's reflection will show us how far removed is this vital force from all others with which it has been compared.

The nicest manipulations of chemical science will probably fail to detect a difference in composition between the microscopic germs of two cryptogamous plants. Each consists of the same elements, carbon, nitrogen, hydrogen, and oxygen, in nearly or quite the same proportions. Both may be planted in a soil which laborious mixture has rendered homogeneous, and subsequently supplied with the same pabulum, and yet, in virtue of some inscrutable, inherent principle, one develops a humble moss, and the other rises into the beauty, symmetry, and even grandeur of a tree fern. The same may be said of the spermatozoa of the mouse and the elephant. Indeed all the phenomena which attend the reproduction of species are totally at variance and incompatible with those which mark the action of material laws. Why, in physical circumstances differing *toto cœlo*, does the germ produce a plant or animal so closely copying the parent? and whence this tenacity of purpose in the germ which reproduces, through a long line of posterity, the trivial characteristics of a remote ancestor. Even within our limited observation we have been struck by the reappearance in the grandchild of the voice, the gesture, the stature, the features, or some other marked peculiarity of his grandsire. Whence comes the force of the axiom that "blood will

tell"?—and how incomprehensible that, by the action of only material laws, mental force, or, it may be, moral infirmity is transmitted from generation to generation, in spite of the system of infinitesimal dilution through which it passes!

Strange as it may seem, there are to-day men, respectable by their numbers and attainments, who are believers in spontaneous generation; but with this proviso which leaves the mystery as great as ever, that only from *organic* matter can organisms be produced. So that to the original and primary appearance of life upon the earth, modern science has given us not the slightest clue.

And now, even with this hurried and sadly imperfect exposition of the tendency of modern science, the time at our command has been consumed. Before leaving the subject, however, I crave your indulgence for a word to those who, wholly absorbed in the study of the laws which regulate the material universe, are so deeply impressed with their universality and potency, that they forget that law is but another name for an order of sequence, and has in itself no force. These are they who, in their pride in the achievements of the human intellect, fail to realize that the universe furnishes conclusive proof that all our philosophy, all our logic, all our observation are utterly inadequate to solve the problems that are presented to us; inadequate not simply from the limited nature of our powers of observation, but because the human mind, though forced to confess the existence of the infinite, is utterly unable to grasp it; and that while the logic of reason and the logic of numbers suffice for a qualified understanding of the manner in which material forces work, of the origin and nature of these forces we are and must ever remain ignorant, unless gifted with higher

powers than we now possess. As has been stated, seen from the stand-point of our modern materialists, and judged by the criteria which they have adopted, spiritual existence and supernatural phenomena, even if as all-pervading as the most devout religionist believes, must, from *a priori* considerations, be utterly ignored. Of those whose regard for the dignity of material laws leads them to reject the idea of a creative and overruling Deity, I would ask, Is not man himself a disturbing element in your universe? Whatever may be said in regard to man's free-agency, and however confidently it may be asserted that his will is but the resultant of the various motives that operate as distinct forces upon it, consciousness lies at the bases of all reasoning; and the conduct of every man proves that he accepts this axiom. As he issues from his door he is conscious, beyond all argument, that it is in his power to turn to the right or to the left; and while he holds himself responsible for his volition, he cannot blame us if we ascribe to him free-agency. Man is therefore an independent power in the universe. He wills and creates. The locomotive is as truly his creation, as himself fashioned from the dust of the earth and vitalized by the breath of the Almighty, is the work of his hands. If, therefore, all the realm of nature is controlled through material laws, by forces that, like attraction, electricity, chemical affinity, etc., act in an invariable and inflexible way, in this universe man is a stupendous anomaly; and unless he can be degraded from his position of preëminence in this material world, the boldest and most irreverant of modern philosophers will strive in vain to dethrone the great Creator from the rule of the universe, or from his place in the hearts and minds of men.

# THE ROYAL FAMILIES OF PLANTS.

No. II.

BY C. M. TRACY.

THE second of the royal lines in the vegetable world affords a view greatly different from the first. That, it will be remembered, consisted of the composite flowers, or the Family of the *Asterids*. Now we will contemplate for a while the family of the second degree of botanical importance. It is familiarly known to us in the Pea and Bean. It has long been called by students the *Leguminosæ;* that is, the Leguminous Plants, or those bearing a legume, or simple pod, for a fruit. Lindley thought proper, in arranging the "Vegetable Kingdom," to call this family the *Fabaceæ*, from *faba*, a bean; but if the reader please, we will employ a title for them here shorter and more convenient, and derived from the group that best typifies the family, which the bean does not. We will term them the *Pisids*, from *pisum*, or the Pea.

The royalty of these *Pisids* is quite different from that of the *Asterids*. Those challenge admiration by their vast numbers and universal presence; but these more by their peculiar nobility of style, whether as to beauty or grandeur. Not that these are much inferior, numerically; for, in the best enumerations of the day, six thousand five hundred species are reckoned, arranged in four hundred and sixty-seven separate groups or genera. We have no calculations made so recently as to warrant our stating very exactly the geographical distribution of these species in various regions. They are not, however, greatly disposed to stray about and play the emigrant over the world's broad acres; but are rather remarkable for sitting down quietly at home, and enjoying their separate dig-

nities in their original possessions, as self-satisfied as the old grandees of Spain. Thus there are species in Australia that no other country can furnish; for they have never travelled from the island yet, whatever they may be tempted to do hereafter. So with those found at the Cape of Good Hope; and even of the European genera there are some that never have penetrated into either Asia or Africa more than a very little way. Yet, in one form or another, they are met with almost everywhere; in fact, we hear only of two spots entirely without them, namely, the islands of St. Helena and Tristan d'Acunha; and perhaps it detracts nothing from the royal wisdom of these plants that they have kept themselves clear of two such Heaven-forsaken places.

Before, however, proceeding too warmly into the admiration of this grand order, we should give the reader some simple means of recognizing it when he meets it. In these familiar views of natural families, we like to bring luminously before the eye of the untechnical lover of plants the few constant marks that we hold to exist in every such family *somewhere*, as the true key to all their mutual relationships, and the fit signs by which they may be readily and definitely known. Now, as we had three marks whereby certainly to know an *Asterid*, so we have three that as certainly indicate a *Pisid;* but whereas in the other case all three are always present, here one may be absent, but never two, and one never disappears at all.

Get the first pea, bean, or locust flower you see. A large flower is easier to study than a small one, and these are the largest we have. The Sweet Pea is, perhaps, best of all, but the bean-flower has some obscurities to the common eye. Turn the flower face to face with you.

All flowers, or at least the great majority, are made up of five leaves or petals; and so is this, if you will believe it. But you can hardly see any such structure; it merely looks like a miniature lady's head in a high-front bonnet of the year 1838. Or perhaps it suggests the idea to you that it has to scores of others, who for years have likened such flowers to butterflies. Hence these plants are often called *Papilionaceous*, from *papilio*, a butterfly. Such notions are all fanciful; but the structure of these flowers is quite decisive. As you now hold it, the large, showy top leaf or petal is one only, and, we might say, about as large as it should be. Below it, right and left, are two more, mated like your gloves; these have been called the *wings*. They are considerably reduced, usually paler, and sometimes of a very different color from the large one above, which we may call the *banner*. This makes three petals. Next, between the wings, wrapped up in them closely in some cases, is what does not look much like a petal or leaf of any sort; but is really the fourth and fifth, very little developed, and grown together by the edges. They make what has always been called the *keel*. This is the structure of the Pea-flower the world over. It never appears outside of the Royal Family of *Pisids*, and it is present there in a vast majority of cases. It is one of the three badges of their regal character.

Next, take a pea or bean-pod, just fit to shell. It is one-sided in its form; that is, the point farthest from the stem is on one side more than the other, so that of the two seams at the edges of the pod one is nearly straight, and one very much rounded. Now split this pod cautiously along the *straight* side. The seeds lie within, and if you have done the thing nicely, you have laid the pod open flat, with each half claiming the alternate seeds, so

that in a well-filled pod of peas, about four are found growing on one side, and as many on the other. This is the structure of the *legume*, or simple pod. Possibly it appears, in some instances, outside the royal family; but very rarely, indeed, if ever. It is not like the pods of the Mustard and Gilliflower, for they have a partition running through them flatwise, and the seeds hang upon both seams instead of one. The pods of the Milkweeds are very different, again, being mere bags in which the seeds are enclosed without the least attachment to any part, but grow upon the end of the stem where it passes into the interior. The simple pod, or *legume*, then, is the second mark of the *Pisids*, and any one can tell it at a glance.

The third mark is simple, curious, and infallible, to the highest degree. The family most likely to be confounded with these is that to which the Rose and the Apple belong; in fact, though we might not expect it, the two run so closely together, that only this third mark is decisive as between them. And yet, all-important as it is, it seems the merest trifle. Look at the bottom of the Pea-flower, outside. There are five small, green, pointed leaves surrounding it, that together are called the calyx, and severally are termed sepals. Now find a flower that grows pretty low down on the stem,—from the angle of a leaf perhaps,—and carefully lift it up against the stem without giving it any twist one way or the other. Thus you bring the real top of the flower to the stem. Notice, now, that if you have worked fairly the stem comes, not against one of the green sepals, but into the notch or space between the upper two of them. The odd sepal, so to speak, is on the outer or lower side. If we had taken a rose or an apple-blossom or the flower of a Spiræa, and so examined it, we should have met just the reverse; the

odd sepal will always be found at top, or next the stem. The invariability of these facts is really wonderful. It is one of those great little things whose discovery sheds such lustre on the genius of Robert Brown, the man whose eye pierced more keenly through the vegetable millstone, than any other man's before or since his time.

Recapitulate then. The marks of the *Pisids* are,—

1. Butterfly, or better, pea-flowers.
2. Legumes, or simple pods, for fruit.
3. The odd sepal turned *away* from the stem.

True, these are not all the marks that are useful in distinguishing this family. But they are the most simple and certain at once. Almost all have compound leaves, such as are found on the Locust, Clover, and Acacia. But we cannot be entirely safe in depending on this; for, not to speak of exotics, the Woodwaxen contradicts the point at our very door. But the Woodwaxen has the three great marks all very plainly, and therefore is a true Pisid, belonging clearly to the royal line, hate it as we will.

In this great family there are three sets, or, as we might say, cousinships. They are each marked by some distinctive properties, and each varies in certain degrees and manners from the typical structure which belongs to all.

First. We have a set with perfect pea-flowers and mostly true pods; but in some, as the Tonka-bean, and the Ground-plum of the West, the pod grows thick and fleshy, and closely resembles a drupe, or stone-fruit of some sort. In this tribe we meet with nearly all the species that afford valuable food to man or beast. We hardly need to cite examples.

Second. We find a set with flowers quite indefinite in

form; some nearly perfect by the type, and others almost as regularly five-petalled and circular as an apple-bloom. But here the pod keeps as close to the normal style as the flower departs, so that we never lose our guide. In this set are the chief medicines and drugs that the family produces. We see examples of this tribe in the Wild Senna and Honey Locust.

Third. A set remains in which the pea-shape is wholly obsolete, the flowers being as completely regular as any to be found. The pods, however, so far as we are informed, preserve the simple form, and our marks are fully vindicated. We have no indigenous plant that belongs here; the greenhouse Acacias are those most familiar. The peculiar properties appear in the abundant production of gum and tannin.

Like princes true, these plants take up nearly every variety of stature, habit, and soil. In regard to size, their range is perfectly enormous. In the gardens are species of Lotus that the gardener loves, and species of Medicago that he hates for the wretched weeds that they are, and neither of them is an inch high, but they creep on the earth like a carpet. There are perfect plants of the Pussy Clover that will go into an ounce vial with little crowding. Then, *per contra*, take the great Locusts of Brazil, described by Von Martius. Fifteen Indians, with outstretched arms, could just encircle the base of one of them. Some were measured and gave eighty-four feet in girth at the ground, and sixty feet where they first became cylindrical in form. This reliable observer made careful calculations on the age of these trees, and carried it back, in some cases, to the time of Homer, and, by all probability, beyond the Christian Era. The style and habit of these plants vary quite as much. The Honey

Locust, especially where at all stunted or neglected, is a tree that a cat can hardly climb, bristling and horrid, a perfect *chevaux-de-frise* of thorns; and the Hog Peanut glides over and round the bushes, where it climbs with a stem hardly strong enough to bear its own foliage, a half invisible thread of green. The Bauhinias bind themselves round the great South American trees like ropes of wire; the Wistarias climb and revel in the Chinese thickets like grape-vines; while the Sensitive Briar creeps timidly among the herbage of the Carolinas, and the graceful little Tare intrudes in northern fields, presuming on its good looks for a chance of renewed impertinence. They are hardly as partial to maritime situations, yet the Beach Pea loves no place so well as its "home by the deep, deep sea," and the Wild Bean equally delights to hang its wanton herbage over bluffs where it can hear the scream of gulls, and see the fisherman casting his lines, hardly more twisted than its own.

As hinted already, the nobility is very different from that of the *Asterids*. That family surprises us by its inutility; this overwhelms us by its wonderful wealth. There is hardly a thing of any use to man that is not, somewhere or other, produced by this family. The other was the royalty of blood and self-complacency; this is that of profusion, extravagance, abundance without limit or stint. We are not writing a volume, and so will not try any enumeration of the thousand products here to be found; but do we desire fine timber? We may take our choice of Rosewood, West India Locust, Itaka-wood, Purple-heart, Acacia-wood, Mora-wood, and a score of others, not forgetting our own Locust, whose fibre defies almost every destroying agent but the borer.

Or would we prefer dyes? Logwood and Indigo, Gum

Lac and Dragon's Blood come at call, with Brazil-wood, Brasiletto, Camwood, Sappan-wood, and Red-sanders. Besides, in India, there are fine yellow dyes from several Buteas, and in Japan from a large tree (nameless to us), while we may have almost as good from the Woodwaxen. If we seek perfumes we shall not go far astray. Tonka-beans, Lign-aloes, Calambac, Balsam of Peru, Balsam Tolu, and Acacia-flowers, are ready representatives in this department. The tanner needs little help from any other tribe if he only have this. The Acacias, Bauhinias, and Cassias give their bark, and Prosopis its pods for his purpose, and they fairly dispute precedence with the Oak and Sumach. In gums they rule the world. Gum Arabic, Tragacanth, Senegal, Animi, Brazilian Copal, and Kino attest this. And yet in drugs their precedence is greater still. Liquorice comes here, with Manna, Senna, Cowhage, Fenugreek, Copaiva, and Catechu, and perhaps a hundred more might be added. If we like to study poisons, we might get a large selection of specimens here; in fact, there is a suspicious character, a kind of royal treachery, underlying the whole group. The beautiful scarlet seeds sold in the shops for beads, and called by the children "Black-eyed Susans," are reported as highly poisonous; certain wild plants of this family once killed whole flocks of sheep in the Swan River Colony; and others are common fish-poisons in Jamaica. Indigo is by some pronounced to be deadly, but others dispute the point seriously. There are not, perhaps, many of these hurtful products that appear as known drugs, but they are none the less present. The seeds of various Sweet Peas have been used in Europe during famine, with such evil effect that they had to be interdicted by government. The Coronillas, common in gar-

dens, are likewise condemned; and the seeds of the Laburnum have done serious mischief.

But despite some poisonous and hurtful tendencies, there is a noble excellence in the royal race. They furnish food unmeasured to thousands of hungry dependents. We may begin with the Peanut, indispensable everywhere, from the Yankee town-meeting hall and circus, to the negro-huts of Senegambia. The quantity of these consumed for food the world over is probably far greater than generally supposed. As to Peas and Beans, not only does the soldier of the Rebellion fully know their value, and every New Englander who loves his Sunday breakfast bear witness, but the world admits it all since the time when Daniel and his three friends grew fatter upon pulse than on the King's meat. The sacred writer does not say they changed their diet from the "King's meat" to the very flesh of royalty, but so it really was. The Tamarind is the cheerful friend of the convalescent, and Shenstone says of a drink skilfully made from it,—

> "Whoso drank the cooling draught
> Would never wish for wine."

There are several sorts, produced by related plants, and known as Brown Tamarinds, Velvet Tamarinds, and Tamarind Plums, all highly prized. The Carob-tree has a pod in which the seeds are buried in a dry, mealy pulp, very nutritious, and eaten freely by horses in Spain and the Levant. It is supposed to be the tree which furnished the "locusts," or locust-pods, that fed John the Baptist in the wilderness. The West India Locust affords something very similar, and as readily eaten. The Parkia, an African tree, furnishes seeds of which the natives make a sauce for meat, in cakes like chocolate, eating also the pulp found in the pods. The famous drink of Central

America, the Chica, deserves mention, as prepared from the sweet pods of a Prosopis; but the manner of making it is such as would forever sicken any one not well hardened in savage life.

Of course these are not all the points of wealth in this noble family. Their treasury never is bankrupt. The Bauhinias have tough bark that makes good ropes. We have in New England a plant called Rattle-pod; and another of this same genus in India produces the Bengal Hemp, very useful for cheap bagging. Some are effectual to destroy vermin, and others yield a juice much employed in the manufacture of Indigo in certain parts of the process.

The beasts fare no worse than their human guardians. At the head of the list stands Clover, so acceptable in its green state to the horse, that it is said that he will eat it till he bursts. Closely related to this are the various species of Lucern and Medick, and sundry Trefoils, all sweet and nourishing to every flock and herd. Saintfoin and Serradilla stand in the same line of usefulness. In the arid deserts of the East grows a stunted bush, the tender character of whose herbage has, in those wastes, earned it the name of the Camel's Thorn. Among the Afghans this plant is depended on above all others for the support of cattle, and if the supply is cut off by war at any time, the herds suffer or perish. So the Woodwaxen is eaten well by sheep, it is said; and many farms, we learn, are pastured in the British Islands at good rates, though they produce little save the prickly "Whin."

Nor would the kingly rank be well sustained by the *Pisids* if they could not boast of beauty; but in this there is no more lack than in other respects. The most splendidly beautiful tree in the world, when in flower, is said

to be the *Amherstia nobilis*, a grand ornament of the Turkish gardens. There also the Cercis, or Judas-tree, lifts its head in purple magnificence; while its plainer, but still charming co-species, the Red-bud of the Canadas and Northern States, is glowing through the woods in the pride of its early bloom. All New Holland is golden with a wealth of Acacia-flowers; and other species, with red instead of yellow, put the most charming blush on the forest-cheek of Mexico. Europe is rich in fine Laburnums; and South America is all aglow with splendid Ingas and Mimosas. The Californian has brought from New Zealand the Glory-pea, and given it a home by his own door, that suits as well as its own. Our own country is full of beautiful plants of this kind; Lupines and Locusts, Hoary Peas, Wistarias and Prairie Clovers, Tick-trefoils and Yellow-wood, Partridge-peas and Ground-plums, all showy and lovely. And whosoever will penetrate the conservatory, and study the floral wealth there displayed by these pea-flowered princes, will find these thoughts well sustained and illustrated.

And yet we have only just come to the most interesting trait in the character of these most royal plants. In them does vegetable life reach its acme, and attain a grade that lacks but the merest step to equal the vitality of animals. The Joint-vetch, of the Virginian river-banks, is sometimes sensitive, and shrinks from the touch, closing its leaflets. Another step, and we have the Sensitive Briar, common through the South, and showing this sensibility in a much higher degree. Then going to Central and South America, we have Mimosas endowed with every degree of this power, till some will hardly bear the human breath upon them, even though they may bear the beating of wind and weather. Great numbers of *Pisids*

keep careful watch of storm and sunshine, however, as well as of day and night, and close their leaves promptly when unfavorable conditions arise. This is but a small matter; other plants do the same; but no other tribe shows such tenderness of feeling in the foliage. Nor do they stop here. In the East Indies grows the strange plant, *Desmodium gyrans*. It may be compared, perhaps, in appearance, to our Wild Indigo, but its leaves are more like those of the Rose. The leaflet at the end only folds up at night and opens by day; but the side-leaflets are always moving, the two sides alternately up and down with a jerking motion, as one says, like the second-hand of a watch. The touch arrests it, or so does cold or narcotics. But left to itself it soon begins again.

Now this, seeing there are here no bones, joints, muscles, or other machinery to execute such movements, is a most astonishing thing. Nearest of anything the world affords does it come to showing the Abstract Life working independently, without mediate agency, and challenging all our skill to grasp it, or account, in any satisfactory way, for the presence that we so unequivocally recognize. Electrical and chemical action are called to explain it, but they fail. We leave it, as one of Nature's mysteries.

This hasty glance gives but a superficial notion of the real grandeur of this most kingly of these Royal Orders. From these considerations, however, we may probably gain sufficient evidence to prove the great importance of these plants in the economy of nature, as related both to man, to the animal kingdom in general, to the great principles of vitality and development, higher and broader than all. A further illustration of these ideas may be had from the study of the other of these families, which will engage our future attention.

# THE HAND AS AN UNRULY MEMBER.

BY BURT G. WILDER, M. D.

[Continued from page 423.]

In the first part of this article, taking for granted that all readers of the NATURALIST are aware that the mammals have two pairs of limbs, of which the hinder are generally called legs, while the anterior are either legs or wings or flippers or arms, according to the use their owners make of them, I made the following statements: 1. That, in spite of great differences in appearance and in the movements which they perform, there is a close anatomical resemblance between the human arm and the foreleg of beasts, the wings of birds, the flippers of seals, etc. 2. That there is a similar resemblance between the leg of man and the hinder limbs of animals. All this is now generally admitted, and, however distasteful may be the actual comparison between the limbs of the bear or of the monkey and our own, we cannot help seeing, that when we get upon all-fours like the one, or stand semi-erect like the other, our limbs really occupy partly the same position in regard to our back-bone as do those of the creatures first mentioned: and I might add, that there is a time in the early stages of growth of all vertebrates, when the limbs are just beginning to form, and are mere little fleshy buds or pads projecting from the sides of the body. (Fig. 6, Plate 12.)

This kind of comparison between the fore or hind limbs of different species is called the study of Homologies, and formerly constituted the whole of Comparative Anatomy. But I also stated that within the past century there has arisen a new kind of Comparative Anatomy, which has for its object the comparison, not of corresponding

parts in *different* animals, but of corresponding parts in *one and the same animal;* in short, the human arm is compared, not with the foreleg of a quadruped, but with the human leg: and in like manner the fore and hind legs of a beast are compared with each other.

And, lastly, I stated that it is now pretty well agreed that in this comparison the shoulder and pelvis represent each other; that the humerus and femur are similar parts in the two limbs; that the elbow and the knee, the forearm and the leg do in some way correspond with each other; and that, finally, the foot is, as a whole, the humble representative of the hand. Yet there is a very wide difference of opinion as to whether or not the great toe is the counterpart of the thumb; and this because the rotation which takes place in the forearm allows the thumb to come into two different positions.

If you will take the trouble to place your hand upon the table, the palm downward, and the fingers pointing forward, you will see that the thumb comes upon the *inner* side of the hand, that is, toward the middle line of the body, as does the great toe in the foot; but if you *supinate* the hand and place it on the edge of the table so that the fingers point backwards, the palm facing downward and forward, you will see that the thumb now comes on the outer side of the hand, and is opposite the little toe.

You will say at once and truly, that the former is the easier and more natural position, and coincides more nearly with your previous ideas respecting the thumb and the great toe, and it might perhaps do very well if the hand and the foot were the only parts concerned; but unfortunately the arm and the leg must also be taken into consideration, and whatever principle we adopt for the former, ought to apply equally well to the latter.

Now what idea is suggested when we compare the hand and the foot in the manner first described? The whole foot points forward, and the sole faces downward and backward; the hand and fingers also point forward, and the palm faces downward and backward: at once we say the corresponding parts point in the same direction, they are *parallel* with each other; and if the hand and foot are parallel, why, of course, the other corresponding parts in the two limbs are or ought to be so too.

But here comes the difficulty. The other segments of the limbs are *not* parallel, but the contrary; the thigh points forward, and the upper arm backward; the convexity of the knee looks forward, while the elbow projects backward; the forearm and the leg likewise point, not in the same, but in exactly opposite directions.

The upper parts of the limbs, then, suggest *antagonism* or *oppositeness;* the hand and the foot suggest *parallelism.*

Which shall yield to the other? Shall the upper segments of the limbs be so turned or twisted or viewed as to conform to the idea of parallelism, or shall the hand be supinated and the fingers made to point backward so as to be in antagonism with the foot? This, as was said, brings the thumb on the outer side, and so into relation with the little toe. To this, the thumb objects, and the whole controversy rests between those who favor it exclusively, and those who are willing to pay some regard to the other portions of the limbs.

The former lay great stress upon the functional superiority of the thumb, upon its size and strength, and upon its constant usefulness at every age, from infancy to the time when the man has leisure to reflect upon its wonderful powers and the prominent part it takes in all the operations of the hand; and in view of all this, they urge

that the thumb should be allowed to associate in this comparison with the largest and strongest of the foot's fingers, at any sacrifice on the part of the upper and less conspicuously useful segments of the arm. But the latter believe that the above considerations do not apply in this kind of comparison, and offer facts and arguments (which will be given in another place) to show why the thumb should not be the only part thought of in this connection, and even that it ought to content itself with whatever position as regards the toes may be most convenient for the upper portions of the limb which supports it.

The former uphold one organ against many, and might for that reason be styled the aristocratic party, but for the somewhat incongruous fact, that at the present stage of the controversy, they far outnumber the more democratic members of the other party, who believe in more equal rights for all the parts of the limbs.

So more appropriate titles may be derived from the two ideas which we have found to be suggested, as the thumb is or is not the first part considered in comparing the hand with the foot. If it is, then Parallelism is the idea, and its advocates are the Parallelists. If not, then Antagonism is the idea, and its advocates are the Oppositists.

Among the Parallelists the more prominent in this discussion are Vicq d'Azyr, Bourgery, Cuvier, Flourens, Cruveilhier, Turenne, Owen, Maclise, Martins, Huxley, Mivart,* and Cleland;† to which list might be added the names of as many more anatomists, who have declared themselves more or less decidedly in favor of one or another of the views advanced by those whose names are given.

Those who have more or less completely adopted the

*Anatomy of Echidna Hystrix. Transactions of Linnæan Society, Vol. XXV. p. 400.

†Quain's Anatomy. Seventh Edition, 1866. pp. 115–117.

idea of Antagonism are Oken,* Gerdy, Agassiz,† Humphrey, Wyman,‡ Foltz,§ and Dana,* with which small number the writer has the honor to be associated.

THE PARALLELISTS. The ancient anatomists contented themselves with pointing out certain obvious correspondences as to general appearance, as those between the bone of the upper arm and that of the thigh, between the knee and the elbow. Their prudent example is still followed by those who do not care to involve themselves in a controversy, and who find it easier to adopt, unquestioned, the opinions of a predecessor; and, in spite of errors and inconsistencies, this method had generally the merit of non-interference with Nature, and may, in medical language, be styled the *expectant* plan of treatment. But a large and distinguished majority of investigators seem to have made up their minds beforehand that something was out of the way, and, in their endeavors to rectify the supposed disordered state of the limbs, have pursued a more heroic course of treatment which, from the various methods employed, may be divided into *dislocation* and *reversion*, *fracture* and *torsion;* or, as their advocates might say, since in their opinion the Creator had already inflicted the above-named injuries upon their unhappy patients, *reduction*, *setting*, and *untwisting*.

*Dislocation with reversion and substitution.* The first to "resolutely undertake and seriously discuss the problem of the comparison between the extremities in man and

*The positions of Oken and of Dana upon this question are peculiar, and will be explained farther on.

† Agassiz and Gould's Principles of Zoölogy. 1848. p. 65.

‡ On anterior and posterior symmetry in the limbs of animals. Proceedings Boston Society of Natural History. June 6, 1860; and June 5, 1867.

§ Homologie des Membres pelviens et thoraciques de l'homme. Journal de la Physiologie. Tome VI. pp. 49–81, and 379–421. April, 1863. The works of all the other authors are cited by Mivart, as in the work already cited, p. 395, and by Martins, Nouvelle Comparison des Membres pelviens et thoracique, etc. Mems. de l'Acad. des Sciences de Montpelier. Tom. III. p. 473.

animals," was Felix Vicq d'Azyr, who published a memoir upon the subject in 1774, four years prior to his election as the successor of Buffon, in the French Academy.

He began his comparison by detaching the right arm (Fig. 2) from the shoulder, and placing it by the side of the leg (Fig. 1). He does not specify the position of the hand in this first comparison, but we must conclude that it was *pronated* so as to face the palm backward like the sole, and to bring the thumb (Po) upon the inner side opposite the great toe, both because this was the universal method of viewing them, and because otherwise the idea of parallelism would hardly have suggested itself at all.

Perceiving the resemblance of the elbow (O) to the knee (Pa), and thinking that, being similar parts, they must face in the same direction, he turned the arm around so that the elbow pointed forward, the hand being left as it was (Fig. 3); the two bones of the forearm (U and R), before crossed, became parallel with each other, the thumb, of course, remaining opposite the great toe.

But although the lower portions of the two limbs were thus in harmonious agreement, the anatomist, on examining their upper ends, perceived that, while the smooth articular surface (Fig. 1, Hd) of the thigh-bone was looking *inward* and toward the middle line of the body, the corresponding surface (Fig. 3, Hd) of the humerus, by which it is attached to the shoulder-blade, was looking in exactly the opposite direction.

What was to be done? If he left things as they were, then the heads of the two upper bones set their faces against his idea of parallelism in the most uncompromising manner; while if he restored them to their original condition, the elbow and the knee came into direct oppo-

sition with the idea and with each other at the same time. To avoid both horns of this dilemma seemed at first impossible; but suddenly it occurred to him to drop the unconformable arm, and to try its fellow of the opposite side; and now, upon placing the *left* arm (Fig. 4) by the side of the right leg, and turning it as before so that the elbow pointed forward like the knee, the two bones of the forearm remaining parallel with each other, he was rewarded for his ingenuity by seeing the articular surfaces of the humerus and femur both looking inward. With this very artificial arrangement he seems to have been satisfied, and dismisses the subject with the remark, that "the correspondences of the fingers with the toes are so evident that it is unnecessary to enumerate them"; either not perceiving or caring that though the fingers pointed forward like the toes, yet the thumb was now upon the *outer* border of the limb, and was thus made to correspond with the *little toe*.

We shall, I hope, be convinced that, in spite of the fact that the thumb and great toe have only *two joints*, the above is really the true relation so far as concerns them alone; but Vicq d'Azyr had no reason for thinking so, since the opinion upon this matter which, then as now, was nearly universal, is well expressed in these words of a later writer, "il est évident pour tout le monde que le pouce est l'analogue* du gros orteil." Vicq d'Azyr seems rather to have been loth to enter into particulars, and really ignores the hand altogether; for it was doubtless the apparent parallelism between the foot and the hand in its ordinary state of pronation that induced him to force the whole limb into a similar relation by turning

*"It is evident to every one that the thumb is the analogue of the great toe." "Analogue" is here incorrectly used by Martins in the sense of "homologue"; in the correctly limited sense of the word, the thumb *is* the *analogue* of the great toe, but it is the *homologue* of the little toe.

the elbow forward; but when he is obliged to take the arm of the opposite side, he seems to have lost all faith in the hand, and leaves it in a position which, though correct in so far as the thumb is made to correspond with the little toe, is inconsistent with his own theory, and inadmissible on account of the displacement of the whole limb. And here was his error, in supposing that a rational comparison of the limb involved not merely a dislocation and reversion of the arm, but a transposition to the opposite side of the body, the right arm being thus made to correspond with the left leg, and the left arm with the right leg. And while we honor the great anatomist, who, in attempting a comparison between different regions of the same individual, really originated a new kind of Comparative Anatomy, which is destined to fill a large place in future investigations, we must deplore the method he employed, a method repugnant alike to common sense and the respect we ought to entertain for the relations God has established between the different parts of the animal frame. And it is doubtless to this pernicious example of Vicq d'Azyr that we must ascribe the extraordinary liberties which some of his successors have taken with the limbs, forcing upon them their preconceived ideas, as if each had said, "if the facts do not accord with my theory, why, so much the worse for the facts."

It is hard for us to believe that the great Cuvier, whose masterly demonstrations of corresponding parts in different animals constituted an era in anatomical science, and at the same time furnished the basis for a true classification, could have been so blinded by his exclusive devotion to Final Causes, and by his dislike for the transcendental theories of St. Hilaire as, during at least the greater part

of his life, to have attached little value to the comparison with each other of parts of the same body; but we could wish that he had ignored the subject entirely, rather than that in 1835 he should have lent the weight of his authority to the views of Vicq d'Azyr, as is shown by the following passage: "C'st la droite d'une paire qu'il faut comparer à la gauche de l'autre."*

Blandin, like Vicq d'Azyr and Cuvier, let the hand and fingers alone, the thumb still remaining opposite the little toe; but, in 1846, this inconsistency was pointed out by Turenne, who, desirous of making all things as harmonious as possible, in imagination, *cuts off the two hands* a little above the wrist, and *transposes them*, which of course brings the thumb on the inner borders, and opposite the great toe (Fig. 1 and 5); nor is it, perhaps, surprising that he should have regarded this as an improvement upon the proceedings of Vicq d'Azyr, and we ought rather to be gratified that, after putting the left arm in place of the right, and again changing the hands, he did not see fit to invert the entire limb, fasten the fingers upon the shoulder-blade, and declare the end of the arm-bone to be homologous with the great toe. Indeed, the whole proceeding is so extraordinary, that, but for the gravity with which it is proposed, one would incline to regard it as a burlesque, intended to bring the original view into ridicule. Yet only ten years ago, the doctrine of Vicq d'Azyr was again, though we hope for the last time, revived.

The errors in this view consist in the assumptions: 1. That the thumb corresponds with the great toe. 2. That the two limbs are parallel. 3. That it is either necessary or proper to compare the arm of one side with the leg of the opposite side.

* "It is the right of one pair that should be compared to the left of the other."

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Fig. 1.

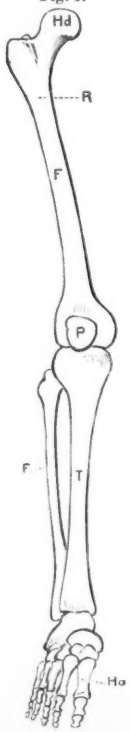



Fig. 2.

Fig. 3. Fig. 4.

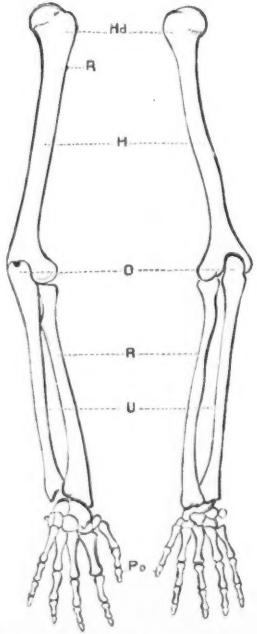
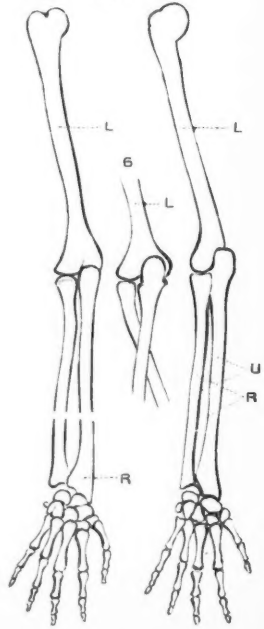



Fig. 5. Fig. 6. Fig. 7.



EXPLANATION OF PLATE 12.

The bones of the limbs are marked as in Plate 11. F, *Femur*, or thigh bone; T, *Tibia;* Fi, *Fibula;* Pa, *Patella*, or knee-pan; Ha, *Hallex*, or great toe; H, *Humerus*, or arm bone; O, *Olecranon process* of elbow; U, *Ulna;* R, *Radius;* Po, *Pollex*, or thumb; Hd, *Head of Humerus*, or *Femur*.

Fig. 1. Bones of human leg, right side; the knee looks forward.

Fig. 2. Bones of human leg, right side; in the position in which Vicq d'Azyr began his comparison; the elbow looks backward, and the forearm is in pronation, the radius being crossed upon the ulna so as to leave the thumb on the inner side. (This and the three following figures are to be supposed *behind* Fig. 1, in order to be compared with it.)

Fig. 3. Right arm turned half way round so as to face the elbow forward like the knee; the hand remains as before, so that the forearm is untwisted, or supinated. The head of the Humerus now faces in the opposite direction to that of the Femur.

Fig. 4. Bones of *left* arm; all the parts agree with the leg except the thumb, which now comes on the *outer* side: this is as Vicq d'Azyr left it.

Fig. 5. This illustrates the comparison of Turenne. The upper parts of the limb are of the left arm as in Fig. 4; but the hand has been cut off and replaced by the right hand as in Fig. 3.

Fig. 6. Diagram of human fœtus, showing the rudiments of limbs.

## REVIEWS.

MANUAL OF THE BOTANY OF THE NORTHERN UNITED STATES, INCLUDING THE DISTRICT EAST OF THE MISSISSIPPI AND NORTH OF NORTH CAROLINA AND TENNESSEE. Arranged according to the Natural System. By *Asa Gray*, Fisher Professor of Natural History in Harvard University. Fifth Edition. With twenty-five plates, illustrating the Sedges, Grasses, Ferns, &c. New York: Ivison, Phinney, Blakeman, & Co. Chicago: S. C. Griggs & Co. 1867. pp. 701. [*Not* including the Mosses and Liverworts, nor the "Garden Botany."]

This new edition of the "Manual of Botany" is the result of the author's continuous desire to improve and make more perfect an early one (published in 1848) "hastily prepared to supply a pressing want."

In the second edition, which appeared in 1856, 2,426 species of Flowering Plants, and the higher Cryptogams, or flowerless plants, were described. In the third and fourth editions species new to science, or newly discovered within our limits, were given in *addenda*, with such alterations in the stereotype plates as were possible. The present edition (almost entirely rewritten) is printed from new stereotype plates, and in it are described 2,634 plants of the Phænogamous and the higher Cryptogamous series; an increase in number of 208. In accounting for so great an increase, we find that 308 out of the whole number are introduced species, being forty-eight more than in the former edition; thirty or forty have hitherto been considered as varieties (or as included in other species), or are new species, and the remainder have been newly discovered within the geographical limits of the work, and, as might be supposed, occur mostly on the borders of the area treated of.*

The most important changes which we notice are the combination of *Nelumbiaceæ*, *Cabombaceæ*, and *Nymphæaceæ* proper as suborders of *Nymphæaceæ*; *Arenaria* is understood as comprising the (sub)genera *Honkenya*, *Alsine*, *Mœhringia*, and *Arenaria*; *Limnanthaceæ*, *Balsaminaceæ*, *Oxalidaceæ* and *Geraniaceæ* proper are now considered as suborders of *Geraniaceæ*; *Saxifragaceæ* is made to include *Grossulariaceæ* and *Parnassiaceæ*; *Holorageæ*, previously merged in *Onagraceæ*, now takes rank as a distinct order; and *Loganiaceæ* has been removed from *Rubiaceæ* to its place between *Gentianaceæ* and *Apocynaceæ*. *Calluna vulgaris* is regarded as a native plant. Our species of *Cuscuta* are described for the "Manual," by Dr. George Engelmann, of St. Louis, Mo.; the name *Lindera* has to be substituted, by the inexorable rule of priority, for the familiar one of *Benzoin*; the genera *Callitriche* and *Euphorbia* have been carefully reëlaborated, as to our species, by Dr. Engelmann, for this edition; the *Cupuliferæ* and *Betulaceæ* have been thoroughly overhauled; the genus *Lemna* has been carefully revised with the aid of notes contributed by Mr. C. F. Austin, and the genus *Wolffia* (represented by *W. Columbiana*)† is now for the first time indicated in a Handbook of Botany, as found in America, though discovered many years ago by Dr. Robbins, who has now monographed anew our species of *Potamogeton*. *Habenaria* is now introduced as including all our species of *Platanthera* and *Gymnadenia*; *Spiranthes*

*The species which are described as new are Lechea Novæ-Cæsaræ, Polygala Curtisii, Sium Carsonii, Aster Herveyi, Lobelia Canbyi, Pyrola oxypetala, Hydrolea affinis, Callitriche Austini, Lemna Torreyi, Potamogeton Oakesianus, P. Vaseyi, Spiranthes simplex, Pogonia affinis, Juncus Smithii, J. Vaseyi, J. asper, Cyperus Lancastriensis, Scirpus Smithii, Aristida ramosissima, Avena Smithii, Isoëtes Tuckermani, and I. saccharata.

†Dr. Engelmann has discovered very recently a second (European) species, *W. arrhiza*, on ponds near St. Louis, Mo.

has undergone changes for the better, and *S. Romanzoviana*, hitherto identified only on the western slopes of North America, where it was long ago found by Chamisso, and at the single station of Bantry Bay, Ireland, is found to be present in the northern part of our region. *Liliaceæ* now includes *Melanthaceæ* and *Trilliaceæ*, and the genus *Narthecium*, and the *Juncí* have undergone a careful and critical revision at the hands of Dr. Engelmann. Much laborious study has been given to the *Cyperaceæ*, and we see the number of *Carices* raised from one hundred and thirty-two to one hundred and fifty-one; the Ferns have been contributed by Professor D. C. Eaton, of Yale College, who has introduced a few changes which we are glad to see, as with *Pellæa* and *Allosorus*, *Polypodium* and *Phegopteris*, and the species of *Botrychium*. The account of our species of *Isoëtes* has been contributed by Dr. Engelmann, who has given them much careful study, and who characterizes within our area seven species, while there are two more in the Southern, and three more in the Pacific States.

We are glad to see the promise of a "simpler and more elementary work," which will include the "Garden Botany" of the last edition, and more, and "designed especially for school instruction, and for those interested in cultivation,—entitled *Field*, *Forest*, and *Garden Botany*." We shall also look with eagerness for a supplementary volume, to contain the *Mosses* and *Liverworts*, newly elaborated we suppose, and the "*Lichens*, if not all the other orders of Lower Cryptogamia." Above all we congratulate Botanists that there is a prospect of the issue, before many years, of a somewhat similar Flora of the whole national domain.

The addition of six beautiful new plates (in the admirable workmanship of Mr. Isaac Sprague), of the genera of *Cyperaceæ*, is an important item to the beginner, and even to those more thoroughly versed in Botany. Every one will be pleased with the slight changes in the typographical execution and arrangement of the work.—H. M.

## NATURAL HISTORY MISCELLANY.

### BOTANY.

*Botanical Notes and Queries.* A recent number of the *Revue Horticole* (Aug. 16, 1867) calls in question the native country of *Sambucus Canadensis* Linn., our common Elder, not only regarding it as a mere variety of the European *S. nigra*,—which it well may be,—but doubting if it be really indigenous to this country. The same doubt had been raised in my own mind. Can any of the numerous readers

of the AMERICAN NATURALIST resolve the doubt by indicating any locality for it away from roadsides and cultivated ground, and quite free from suspicion? The same journal calls more decidedly in question, the American origin of *Robinia hispida*, the common Rose Acacia, and conjectures that it is an extraordinary form of the common Locust. This more unlikely opinion is based on the fact that this shrub sets no fruit either in the old world or the new; also that, on inquiry, no one seems to know it away from cultivation. This year, however, some pods are forming in France. Has any one seen pods and seeds in this country? The inquiry is in this case particularly addressed to Southern correspondents. There are in cultivation forms singularly intermediate between *R. hispida* and the *R. Pseudacacia*, or common Locust, but these are more likely hybrids. The Rose Acacia is said to be indigenous to Georgia, apparently with good reason. But definite indications of it, and fruiting specimens are desirable.

As the above-mentioned number of the *Revue Horticole* gives a figure and description of that charming hot-house climber, *Clerodendron Thompsonæ*, I may take this occasion to refer to the curious, and perhaps as yet unnoticed, arrangement of its stamens and pistils, so as to favor, if not to secure, *cross-fertilization*. The long and slender filaments and style in the flower-bud are rolled up in an incurved coil, after the manner of the genus. When the crimson corolla opens, setting these organs free, the filaments straighten at once into nearly a horizontal position, and their anthers opening are covered with fresh pollen; while the slender style is strongly recurved, carrying the forked stigma downwards and backward far under the flowers. After about twelve hours, say at sunset when the blossoms have opened in early morning, the filaments begin to curve downwards, and the style to straighten; and before the next morning the filaments are rolled up into a spiral coil the reverse of that in the bud, placing the anthers under the tube of the corolla, while the style has risen to the horizontal or slightly ascending position, so placing the stigma where the anthers were the day before. Evidently there is only a short period during which a moth, or such insect, visiting the flowers can brush any pollen from the anthers to their own stigma; but the pollen of freshly opened flowers will, in the progress of the insect from blossom to blossom, be carried to the stigma of those which have expanded the day before. — A. GRAY.

*May-apples in Clusters.* — In the new edition of the "Manual of the Botany of the Northern States," it is too briefly mentioned that *Podophyllum* has been found in Ohio, by W. C. Hampton, with two carpels! I would here add, that, on a visit to the Agricultural College of Penn-

sylvania last summer, my friend, Professor H. J. Clark (whose acute original observations I have frequently had to record), showed me several clusters of well-grown fruits of *Podophyllum*, of three or four upon one stalk, and evidently from one flower; and I think he remarked that they were not very uncommon. I wish to obtain some of these anomalous *Podophyllums* in flower. There is reason to expect now and then a similar monstrosity in *Jeffersonia;* and the matter has a certain botanical interest beyond the mere curiosity of the thing. — A. GRAY.

*Invasions of Foreign Plants.* — The prepotency of foreign plants over original vegetation, especially in the New World, in New Zealand, Australia, etc., has of late attracted attention and remark. That foreign weeds should usurp the cleared soil in this part of the country, which was originally forest-grown, is only what would be expected. But the vegetation of our more unwooded regions West and South ought to furnish plants capable of holding their own against intruders, even under present changed conditions, unless, as has been suggested, a set of plants of the Eastern world which have fought their way into Europe against all indigenous opposers, have thereby at length acquired a hardihood and generally belligerent disposition, which enables them to conquer new worlds wherever they get a foothold. Somehow or other these plants do seem, in this respect of prepotency, to take after the particular human race whose footsteps westward they follow.

These remarks are suggested by a recent instance of the sort, on the part of a Chinese or Japanese leguminous plant, *Lespedera striata* Hook. and Arn., which has got an introduction, nobody can tell how, into the interior of Alabama, Georgia, and South Carolina, and is now multiplying at a wonderful rate. I first received it a year ago, but Professor Darby informs me that he detected it about ten years ago, at the railroad station in Altoona, Georgia, and he has lately met with it in all the adjacent States. "Now," he adds, "it covers thousands of acres, and is rooting out everything, even our Bermuda Grass (itself a foreigner). "When I first came to this place [Auburn, Georgia], the *Maruta cotula* covered all waste places; in a few years the [native] *Helenium tenuifolium* took possession. Now, this *Lespedera* has conquered them both." The newspapers have lately mentioned that "a new grass, of the nature of a clover," has widely appeared in the Southern States. This is probably the thing. If it be a decent forage plant, as it well may be, this intruder, which takes such a liking to the poor soil of the South, will prove a real blessing to the country. — A. GRAY.

A VARIETY OF THE OX-EYE DAISY.—I am not a little interested in the note in the NATURALIST for September, by Professor Tenney, in relation to the form of the Ox-eye Daisy, which he suspects to be new. Although this form may be new to science, in that it has not been hitherto described, yet this is certainly not the first time it has been detected. Within a period of fifteen years past, I have found it some three or four times, I think; and I never suspected it to be anything but a chance variety of *Leucanthemum vulgare*. In the summer of 1865, it was brought to me from a spot close by my house, agreeing in all respects with the description by Professor T.; and wishing to try the effect of cultivation upon it, I transplanted a good root to my garden, but it was afterward destroyed by accident, before the result could become known. I cannot believe it to be specifically distinct from the common *Leucanthemum*, or anything more or less than a variation, through accidental causes, from the normal state of the species. To my mind it stands in the same line with the petaloid form of *Penthorum*, or the "*Peloria*" condition of *Linaria vulgaris;* and many other genera might be cited as furnishing instances of like departures now and then from the ordinary and natural style.—C. M. TRACY.

## ZOÖLOGY.

THE BREEDING HABITS OF BIRDS.—In reading the lately published work of Mr. Samuels, on the Ornithology and Oölogy of New England, I noticed some statements regarding the breeding habits of some of our birds, which are at variance with my own observations.

Of the Belted Kingfisher he says: "The birds on arriving commence pairing, and they soon begin excavating in a sand-bank a long, winding hole, of about three inches and a half in diameter at the entrance, and gradually larger to the end, at which the nest, composed of grasses, leaves, and feathers, is built,—or laid, which would, perhaps, be the better term. This hole is sometimes as much as six or eight feet, usually from four to six, in length." Page 126.

My experience in regard to the breeding habits of the Kingfisher is entirely at variance with the above. Of two burrows found last spring, one measured thirty-four, and the other thirty-five inches in length; they were excavated in the form of an elbow. The passage leading from the entrance in one of them was sixteen inches in length; and then turning to the right, lead to a cavity of about ten inches in diameter, the bottom of which was three-fourths of an inch below the bottom of the way leading to it, and four and a half inches in height, being in the form of an oven; including the cavity,

the length of this part of the burrow was eighteen inches. The eggs were placed in the hollow *on the bare earth*. I have seen many of their burrows, and have yet to find one in which a nest is made of any material.

Again he says: "The Mottled Owl selects for a nesting-place a hollow tree, often in the orchard, and commences laying at about the first of May, in the latitude of the middle of Massachusetts. The nest is made at the bottom of the hollow, and is constructed of grass, leaves, moss, and sometimes a few feathers. It is not elaborately made, being nothing more than a heap of soft materials." Page 67.

This is another instance in which the bird makes no nest, or at least I have never found one. All rapacious birds are awkward workmen at nest-building, especially the Owls. Those Owls which occupy a nest at all, usually select the abandoned nest of the Crow or Hawk; sometimes they select one in a most dilapidated state, in which case they repair it with dried sticks, sometimes green ones with the leaves adhering, which they break from the neighboring trees; and with bark collected from dead limbs, etc.; very seldom do they construct a new nest.

The difficulty with which Owls and Hawks obtain the material for building their nests, compels them to use the same nest year after year; the upper mandible so overhangs the lower one, that it is difficult for them to pick up a stick from the ground, and they often use their claws to carry the material.

Had not Mr. Samuels been an eye-witness of the weaving capacity of the Marsh Hawk [page 48], I should doubt the power they possess in so combining the materials of their nest as to cause them to appear to be woven. In many instances they merely trample down the grass in the meadow, and lay their eggs on the bare turf; and when they pretend to build a nest it will not compare in architecture with that of the common hen.

I make these statements, because I believe facts concerning the habits should be given as well as the minutiæ of classification, as in this way information will be the better imparted to those seeking knowledge; and we shall then have the natural history as well as the nomenclature of birds.—Augustus Fowler, *Danvers, Mass.*

Change of Color in Fish.—A medium-sized "horned-pout," in a dining saloon in this city, changed color in a few days from black to a very bright clear color. The fish has remained in running water some weeks in a set marble bowl, where soft water runs all the time. This fact may help to confirm Mr. Bolles' observation mentioned in the Naturalist, p. 391.—W. B. Chamberlain, *Worcester.*

### ANSWERS TO CORRESPONDENTS.

Can you inform me what is the use of the comb-like formation on the inside of the middle claw of the Night-heron, the Night-hawk, and Whippoorwill? Is it peculiar to night birds? I find it on those mentioned, and have not noticed it on any bird of the day that I have shot, or is in my collection. — BALDWIN COOLIDGE, *Lawrence*.

We referred these questions to Dr. T. M. Brewer, who thus writes: I have shown your letter to Mr. G. A. Boardman, and have secured a very satisfactory explanation from him of the purpose and use of the "formation" in question. It is used by the birds to clean their heads, and such portions of their neck, back, etc., as they cannot reach with their bills. He often finds them containing feathers, down, dead skin, etc.

H. W., Massachusetts. — The Fern, from Genesee, N. Y., you enclose, is apparently nothing but a poor specimen of *Asplenium thelypteroides* Michaux.

## PROCEEDINGS OF SCIENTIFIC SOCIETIES.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE. — NATURAL HISTORY SECTION. *Burlington, Vt., August* 21–26, 1867. "Considerations relating to the Climate of the Glacial Epoch in North America," by Professor E. Hungerford. The special object of this paper was to discuss the growth and the climatic influence of such an accumulation of snow and ice as the glacial hypothesis supposes to have once existed.

The author called attention to the extremely broken condition of the northern border of the continent, and to the probable effect of a local elevation of that region above its present level, in lowering the snow line by a depression of the summer temperature. A large extension of the area of perennial snow would result from this. But every one hundred feet of snowy accumulation would be more than equivalent in climatic effect to a hundred feet of continental elevation, owing to the peculiar nature of a snowy surface. Every such additional accumulation would depress the summer temperature still farther, and give further extension to the area of perennial snow. This process would go forward until some great reactionary cause is introduced. We should thus have a great snow and ice plateau, covering the northern portions of the continent, without resorting to a very extended upward movement of the continental mass.

The paper then entered upon a discussion of the direct frigorific effects of such an immense plateau, composed of such material, contrasting it with a similar plateau of bare earth, and applying to it various meteorological considerations, all tending to show that in the interior of such a plateau an intensely cold climate would continue through the year.

Application was made of these considerations to the question of a simultaneous motion of a continental glacier in one determined direction. Extreme cold operates adversely to glacial motion, and ground was taken against the probability of such a general simultaneous movement, in such a climate and with no sufficient slope of the country.

The erosive effects which we witness, and which are due to glacial action, are ascribed to a motion always sustained along the southern or seaward margin of the glacier, where a milder climate would prevail. The glacial front itself furnishes the slope, and heavy precipitation above supplies the waste below. Every section of country is twice scoured over, — once during the growth, and once during the retreat of the glacier. By the same motion the detritus is transported over limited distances. For the remote transportation of drift, the agency of icebergs and ice-rafts is necessary. This latter point is discussed in the paper on the Ripton Sea-beaches.

"The Ripton Sea-beaches," by Professor E. Hungerford. This paper gives a somewhat detailed description of a series of terraces, situated on the west flank of the Green Mountains, in Vermont, on the pass from Ripton to Hancock. They are elevated 2,196 feet above the ocean. Drawings were exhibited in which the distinct terrace forms were displayed, extending up the gorge which forms the pass. Evidence was adduced to show that the materials of the terraces overlie the true boulder drift of the region, and that they thus constitute a modified drift deposit, worked down by waves and currents into their present position and form. The configuration of the country being regarded as unfavorable to the accumulation of a large body of fresh water at this point, these deposits are cited as a strong confirmation of other evidence, that this region has suffered a depression of at least 2,000 feet beneath the sea since the glacial epoch proper.

The author of the paper took occasion to concisely present his views in regard to the causes operating to produce the drift phenomena. The geological events enumerated succeeded each other in the following order: —

1. The formation of a continental glacier to whose partial movements, always limited to a comparatively narrow belt upon the southern or seaward margin, are due the erosive phenomena, and the transportation of the drift over limited areas.

2. A depression of the continent, bringing the ocean into contact with the long glacial border, which, on its retreat, sends off icebergs and icerafts into the ocean. To these are attributed the further transportation of detritus and boulders.

3. Emergence of the continent,—the higher beaches marking the earlier, and the Champlain terraces the later stages of this process.

"On the Geological Relations of the Mastodon and Fossil Elephant of North America," by Professor James Hall, of Albany. Professor Hall spoke of the geological position in which remains of the mastodon had been found. These remarks chiefly applied to those specimens found in the State of New York, especially describing the location and position in which the skeleton was found at Cohoes last autumn. He was inclined to think that these remains were left in their scattered position by the melting of a glacier. He considered the facts as evidence that the mastodon extended back to the close of the glacial epoch. The paper stimulated so lively a discussion that the time of the session was extended three-fourths of an hour, when a farther discussion was postponed till the next day. During the discussion Professor O. C. Marsh, of Yale College, said that he had seen mastodon bones from Kentucky scratched and furrowed like glacial boulders. Remains of two or three species are found in North America, one of which found in the upper Missouri region lived in the Tertiary period, and hence was much more ancient than that found at Cohoes. It is known that the mastodon lived in Europe and in India previous to the glacial epoch, and he showed that the American facts perfectly coincided with foreign observations. He noticed that remains of an elephant, identical with the one found in Siberia, were numerous in Russian America, and he suggested that the day might come when fossil ivory would become an important article of export from that territory.

"Considerations drawn from the Study of the Orthoptera of North America," by S. H. Scudder, of Boston. This paper gave a general account of the Orthopteran (grasshoppers, crickets, and the like), fauna of North America compared with that of Europe; showing the greater comparative richness of the American fauna under similar climatic influences. It was followed by a more detailed notice of the groups which are characteristic of one continent in contrast with those forming the essential features in the fauna of the other.

"On recent Geological Discoveries in the Acadian Provinces of British America." By J. W. Dawson, LL.D., F.R.S., Principal of McGill University. The object of the paper was to notice some recent discoveries, which, though of interest, might have escaped the notice of members of the Association.

In New Brunswick, the older rocks in the vicinity of the city of St. John have been reduced to order, and their probable ages ascertained, principally through the labors of Mr. Matthew, Mr. Hartt, and Professor Bailey. The first step toward the knowledge of their precise date was the discovery of a rich land flora in some of the upper beds, next below the Lower Carboniferous rocks which overlie them unconformably. These fossil plants I was enabled to recognize as of the Devonian Period, and the zealous researches, more especially of Mr. Hartt, have brought to light no less than forty to fifty species, or half of the whole number known in the Devonian of Eastern America, as well as six species of insects, four of which have been described by Mr. Scudder.* These insects are the first ever found in rocks older than the Carboniferous.

These rocks, consisting chiefly of hard shales and sandstones, having been ascertained to be Devonian, there still remained an immense thickness of underlying rocks of uncertain age. In the upper member of these rocks, the same active observers already mentioned have observed a rich primordial fauna, embracing species of *Conocephalites*, *Paradoxides*, *Microdiscus*, and *Agnostus*, as well as an *Orthis*, and a new type of Cystidians. These fossils are regarded by Mr. Hartt and Mr. Billings as of the age of Barrande's "Etage C," and as marking a new and older period of the "Silurian Primordial" than any other as yet recognized in America, with the exception of the slates holding *Paradoxides* in Massachusetts, and the similar slates of the "Older Slate Formation" of Jukes, in Newfoundland. Descriptions of these fossils, by Mr. Hartt, will be published in the edition of "Acadian Geology" now in press. It is proposed to call this series, represented in New Brunswick by the St. John slates, the *Acadian Series*.

Below these primordial beds are highly metamorphosed rocks, at least 9,000 feet in thickness, which have afforded no fossils. A portion of these beds, consisting principally of conglomerate and trappean beds, is regarded by Messrs. Matthew and Bailey as of the age of the Huronian. The remainder, containing much gneiss and a bed of crystalline limestone, they regard as Laurentian. If this view is correct, and it certainly seems to be probable, these rocks thus rising through the oldest members of the Lower Silurian, and forming a stepping-stone between the Laurentian of Newfoundland and that of New Jersey, show that the foundations of the north-east and south-west line of the east side of North America were already laid in the Laurentian period. Still, it is not here, but farther west, that we are to look for the dividing line between the great inland Silurian basin of America, and that of the Atlantic coast; the latter as has been pointed out by

* Canadian Naturalist and Geologist. 1867.

Professor Hall and Sir W. E. Logan, so remarkably distinguished by the predominance of mechanical sediments, and by a development of the lower rather than the upper members of the Lower Silurian.

To ascend from these rocks to the Carboniferous, — recent labors of Mr. Davidson, Mr. Hartt, and the author, had led to the division of the Lower Carboniferous into successive subordinate stages, and to the determination of most of the marine fossils, and also to the explanation of the curious and apparently anomalous fact that some forms allied to Permian species actually exist in the Lower Carboniferous, under the productive coal-measures. These researches had also shown that no distinction between Sub-carboniferous and Carboniferous proper, can fairly be made in Nova Scotia, notwithstanding the grand development of the Carboniferous in thickness.

After noticing the large advances made in the fossil botany of Nova Scotia and New Brunswick, the paper referred to the discovery by Mr. Barnes of two new species of insects, and to the discovery by the writer of a new pulmonate mollusk, described by Dr. P. P. Carpenter, as *Conulus priscus*. There are thus in the coal formation of Nova Scotia a *Pupa* and a *Conulus* or *Zonites*, generically allied to living pulmonates, and representing already in that early period two of the principal types of these creatures.*

Specimens of these fossils were exhibited, and also specimens and a photograph of the Laurentian fossil *Eozoön Canadense* sent by Sir W. E. Logan. Special attention was drawn to the specimen recently found by the Canadian Survey at Tudor, which shows this organism in a state of preservation comparable with that of ordinary Silurian fossils.

"On the Distribution of Radiata on the West Coast of America." By Professor A. E. Verrill. In this paper the author has endeavored to present all the facts hitherto published in regard to the geographical distribution of the Radiates along the entire Pacific coast of America, as well as many new observations upon those found in the tropical region.

The present state of our knowledge indicates that the entire coast may be divided into at least eleven regions, or zoölogical provinces, each characterized by a peculiar assemblage of species and genera, some of which are restricted to each province, while others pass the bounds into adjacent provinces, on one or both ends, in diminished numbers. Temperature was shown to be the principal physical agency in limiting the distribution of species, but the nature of the bottom and the character of the shores have their influence. The depth of water probably has a direct influence on certain

*Acadian Geology. Second Edition.

species, but its principal influence is *indirect*, by influencing temperature, increase of depth being, in the sea, analogous to increase of elevation upon land, diminishing the temperature and allowing northern animals to extend in deep water farther toward the equator than upon the shore. The number of species of each class of Radiates found in the several provinces was stated, together with those that were peculiar to it, and those that range into other provinces north or south. The Arctic division of the coast north of Sitka, was shown to be characterized chiefly by circumpolar species, found also on the North Atlantic coasts of America and Europe, and, in some cases, upon the North Pacific coast of Asia; several of the common New England Star-fishes, Sea-urchins, and Actiniæ are examples of species having this wide northern distribution. Each of the other provinces was compared with the adjacent ones, and with the parallel provinces of the Eastern American coast and the coast of Europe, most striking resemblances to the latter being common. The Tropical or Panamian province, extending from the head of the Gulf of California and Cape St. Lucas to Cape Blanco, Peru, was compared with the Caribbean province, extending on the Atlantic coast from Florida to Brazil, and including the West Indian Islands. Very few species of Radiates are recorded as identical between the Atlantic and Pacific, and these are all Holothurians, and therefore doubtful. The Polyps and Corals are remarkably different, not only in species, but often in genera and families. No coral-reefs occur on the Pacific side, but several corals of considerable size occur. The Panamian Acalephs are almost unknown. A small per cent. of Mollusca are admitted as identical on the two coasts, by Dr. Carpenter, and of Crustacea and Fishes by others; but the general correspondence in the genera and families in these groups and in Echinoderms is very remarkable. There is no direct evidence of a water communication across the Isthmus since the Cretaceous period, but shells have been found in the Miocene of San Domingo, and near Aspinwall, allied more nearly to living Panamian shells than to those of the Atlantic. All the evidence is against the supposition that the Gulf Stream has flowed across the Isthmus, since the existence of living species. And there is more evidence of existing Pacific species passing into the Atlantic, than the contrary.

In conclusion, it was thought that a depression of about three hundred feet, causing a connection across the Isthmus by means of a shallow estuary of brackish water, sufficiently pure to sustain the life of many Mollusca, Crustacea, and Fishes, but not the floating germs of Corals and other Radiates, would sufficiently account for the distribution of all the known identical species. But to account for the distinct but similar species belonging often to genera not found in the East In-

dies and Central Pacific, it will be necessary to suppose that they were created separately, as we find them, each adapted to its province; or else that they have descended from common ancestors, becoming gradually different by natural selection or otherwise, and pointing to an earlier, very ancient, and extensive connection between the two oceans.

Prof. O.C. Marsh exhibited some remarkable fossil Sponges from the Lower Silurian of Kentucky, for which he had recently proposed the new genus *Brachiospongia*. The type of the genus was *B. Rœmerana*, and several other species have recently been discovered. These forms are very unlike any known sponges, recent or fossil, and are of great scientific interest. A full description of them will soon be published.

"On certain Effects produced upon Fossils by Weathering." By Professor O. C. Marsh. Certain peculiarities in some fossil shells, which had been a puzzle to the German geologists, were very clearly explained by Professor Marsh as due to the action of the elements, the parts of the shell being differently composed and of different degrees of hardness. This has been most frequently noticed in fossil Cephalopods, which in some instances show lobe-lines, characteristic of two different genera on the same specimen. This is very often the case with *Ceratites nodosus*, from the Trias of Germany.

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NOTE.—This number is devoted largely to the proceedings of the American Association for the Advancement of Science. In order to make room for the valuable and interesting address of the President, and the abstracts of papers read in the Natural History Section, we have crowded out articles and illustrations originally intended for this number.

We trust all our readers will feel an interest in the growth and full success of the American Association, whose meetings are doing so much for the diffusion and advancement of Science in this country, and prove such pleasant reunions for all interested in the cause.

The abstracts of the papers will be continued in future numbers.

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## BOOKS RECEIVED.

*Life Beneath the Waters; or the Aquarium in America.* By Arthur M. Edwards. New York, 1858. 12mo. Illustrated.

*On a Fungoid Parasite, or Caterpillar Fungus, from the Philippine Islands.* By Dr. Samuel Kneeland. (From the Proceedings Boston Society Natural History.) 1867. 8vo, pp. 6.

*Notes on Fossils recently obtained from the Laurentian Rocks of Canada, and on objections to the organic nature of Eozoön.* By J. W. Dawson, LL. D.; with Notes by W. B. Carpenter. Plates XI and XII. (From the Proceedings of the Geological Society, London, May 8, 1867.) 8vo, pp. 7.

*Catalogue of the Lepidoptera of New Orleans and its vicinity*; prepared by L. Von Reizenstein. New Orleans, 1863. 16mo, pp. 10.

*Mental and Social Culture; a Text-book for Schools and Academies.* By L. C. Loomis, New York. J. W. Schermerhorn & Co. 1867.

# OBITUARY NOTICE.

It is our painful duty to announce the death of the President of the Essex Institute, which took place at his residence in Salem, on Thursday evening, October 31, 1867.

Francis Peabody, born at Salem, December 7, 1801, was a son of Joseph Peabody, an eminent merchant of Salem during the close of the last and the beginning of the present century. Soon after leaving school he made an excursion to Russia and Northern Europe, and on his return settled in Salem, where he continued to reside until his decease, except during occasional visits to Europe. He was early interested in the study of chemistry and the kindred sciences, and their application to the useful arts. He was the first President of the Board of Trustees of the Peabody Fund for the promotion of science and useful knowledge in the County of Essex; a member of the American Academy of Arts and Sciences, and other institutions.

In November, 1827, the Essex Lodge of Free and Accepted Masons, in Salem, of which body he was an honored member, voted to have a course of Literary and Scientific Lectures; about the same time the Salem Charitable Mechanic Association appointed a committee to provide for the delivery of lectures before the members and their families. Before both of the above-named institutions Mr. Peabody delivered several lectures on the Steam Engine, Electricity, Galvanism, Heat, and similar subjects. At the organization of the Salem Lyceum in January, 1830, Mr. Peabody took a leading part, and was on the first board of management, and delivered several lectures on scientific subjects. These several institutions may be considered as having made the first movement in the general introduction of popular and instructive lectures, which have been so universally adopted in this country.

About 1826 Mr. Peabody engaged in the manufacture of white lead, which business he pursued until 1843. During that period he was also interested in the manufacture of paper and linseed oil, and owned establishments for the refining of sperm and whale oils. From that

time, until his decease, he engaged extensively in commercial enterprises, in connection with one of his sons, and had recently erected a mill for the manufacture of gunny cloth on new principles.

Mr. Peabody had a very active and inventive mind, and was always interested in the conducting of experiments in the Physical Sciences, or in the invention of machinery useful in the arts. He had always been an efficient and zealous member of the Institute, and in May, 1865, was elected its President; during his official connection with that body he contributed very largely for the promotion of its objects.

The decease of the President will not only be a great loss to the Institute but to the community in which he had spent an active and useful life. His memory will long be cherished for his many virtues and his great interest in all worthy undertakings.

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At a meeting of the Essex Institute, held on Saturday, Nov. 2, 1867, Vice-President A. C. Goodell, jr., in the chair, the following Resolutions, offered by Henry Wheatland, were unanimously adopted: —

*Resolved*, — That the Essex Institute receives the tidings of the decease of its President, FRANCIS PEABODY, Esquire, with profound sorrow; that in his death it recognizes the loss, not only of its most devoted, laborious and enthusiastic chief officer, but of a friend and patron of science and the useful arts, who, while distinguished for his accomplishments in a wide field of intellectual inquiry, was indefatigable in reducing the results of his investigations to practical use; a citizen who used his liberal means to advance the welfare of his neighbors by the encouragement of industry and the discovery of new sources of profit; a man whose life was characterized by untiring devotion to those studies and pursuits which lead to the highest and most enduring prosperity of any community, and, in its more intimate and private relations, was pure and blameless.

*Resolved*, — That, as a mark of respect to the memory of the deceased, the Rooms of the Institute be closed to the public on Monday, Nov. 4, and that the members assemble at this place on that day, at 12.30 P. M., to attend the funeral of their late President.

*Resolved*, — That the Hon. C. W. Upham be invited to prepare a Eulogy upon the life and character of the deceased, to be read before the members of the Institute at such time as shall be hereafter determined upon; and that the Trustees of the Peabody Fund be invited to participate in the exercises of that occasion.

*Resolved*, — That a copy of these Resolutions be presented to the family of the deceased, to whom the Institute hereby tenders its sincerest sympathy and condolence; and that a copy be also forwarded to George Peabody, Esquire, of London, who so much relied upon the deceased for the wise management of his large donation for the promotion of science and useful knowledge in the County of Essex; between whom and the deceased the warmest feelings of kindred and friendship existed.